Plant–eriophyoid mite interactions: cellular biochemistry and metabolic responses induced in mite-injured plants. Part I

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Received: 24 July 2009 / Accepted: 26 February 2010 / Published online: 13 March 2010
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Abstract This review is a comprehensive study of recent advances related to cytological, biochemical and physiological changes induced in plants in response to eriophyoid mite attack. It has been shown that responses of host plants to eriophyoids are variable. Most of the variability is due to individual eriophyoid mite–plant interactions. Usually, the direction and intensity of changes in eriophyoid-infested plant organs depend on mite genotype, density, or the feeding period, and are strongly differentiated relative to host plant species, cultivar, age and location. Although the mechanisms of changes elicited by eriophyoid mites within plants are not fully understood, in many cases the qualitative and quantitative biochemical status of mite-infested plants are known to affect the performance of consecutive herbivorous arthropods. In future, elucidation of the pathways from eriophyoid mite damage to plant gene activation will be necessary to clarify plant responses and to explain variation in plant tissue damage at the feeding and adjacent sites.

Keywords Vagrants · Mite gall formers · Sap-sucking feeders · Compatible and incompatible interactions

Introduction

Among phytophagous mites, the eriophyoid mites (Acari: Prostigmata: Eriophyoidea) are the most diverse group and many of eriophyoid species are economically important (Van Leeuwen et al. 2010). Around 3,700 species are currently recognised (Amrine et al. 2003) on angiosperms, coniferous plants and ferns throughout the world. Exceptional morphological, physiological and behavioral traits of eriophyoids (Nuzzaci and Alberti 1996)
allow them to specialize in feeding on particular plant genotypes, and even on a single vegetative and/or generative plant organ (Jeppson et al. 1975; Boczek and Griffiths 1994; Westphal and Manson 1996). Therefore, most of them are highly host specific (Keifer et al. 1982; Boczek and Griffiths 1994; Oldfield 2005). However, a few species are known to inhabit a wide range of host plants (Jeppson et al. 1975; Westphal 1980; Meyer 1987; Oldfield 1996a). Meristems and young, soft tissues of all aboveground plant organs are preferred by eriophyoids presumably because of their high nutritional value. Interaction of host plant genotype, mite species and environmental factors result in the final form of plant/organ symptoms (Weis et al. 1988; Easterbrook and Palmer 1996; Rancić et al. 2006; Royalty and Perring 1996; Westphal and Manson 1996; Duso et al. 2008; Rancić and Petanović 2008). The consequences of eriophyoid mite feeding can range from symptomless to toxemias, and non-distortive effects such as russeting, silverying, bronzing etc., and formation of galls, distortions or other abnormalities and formation of a rapid necrotic lesion (hypersensitive reaction, HR) (Oldfield 1996b; Royalty and Perring 1996; Westphal and Manson 1996; Westphal et al. 1996). Although great progress has been achieved in research on plant–mite relationships in the second part of the twentieth century (Boczek and Griffiths 1994; Nuzzaci and Alberti 1996; Oldfield 1996a, b; Royalty and Perring 1996; Westphal and Manson 1996; Westphal et al. 1996; Duso et al. 2008), the limited knowledge we have on many aspects of eriophyoid mite–host plant interactions merit further investigation.

The present review related to plant–eriophyoid mite interactions consists of two parts. Types of morphological alterations of host plant organs with respect to eriophyoid life styles, as well as the variety of plant symptoms characteristic of eriophyoid damage are analysed in the second part of the review (Petanović and Kielkiewicz 2010). The aim of this review (Part I) is to present the new synthesis of results concerning plant–eriophyoid mite interactions with respect to cytological, biochemical and physiological effects achieved to date. Our intention was to compare results obtained by 1996 with those published within the last 15 years. In the light of new data, we tried to find possible explanations to previously presented results or raise the same unanswered questions, and finally suggest how future studies could answer our long-standing queries.

From eriophyoid mite stylet penetration to cell injury

The morphology of eriophyoid gnathosoma, its function and movement have been studied in detail by several authors (Keifer 1959; Shevtchenko and Silvere 1968; Jeppson et al. 1975; Silvere and Shtein-Margolina 1976) and reviewed by others (Krantz and Lindquist 1979; Lindquist 1996; Westphal and Manson 1996). Although the involvement of gnathosoma structures in the feeding process has been shown, not all phases are fully known (McCoy and Albrigo 1975; Hislop and Jeppson 1976; Nuzzaci 1979; Nuzzaci and Alberti 1996). The stylets of eriophyoid mouthparts are inserted into the cell wall mechanically (Keifer 1959; Shevtchenko and Silvere 1968; Krantz 1973; McCoy and Albrigo 1975; Hislop and Jeppson 1976; Nuzzaci 1976), where they cut and drill, and three glands (paired and unpaired) produce secretions (Nuzzaci and Alberti 1996). The paired glands presumably function as true salivary glands (Thomsen 1988; Nuzzaci and Alberti 1996), whereas the function of the unpaired one is still to be elucidated.

Eriophyoid saliva injected from the mouthparts enters the plant cells. As indicated by the review of Nuzzaci and Alberti (1996), the saliva travels between cheliceral stylets and labrum into the plant cell, whereas plant cell content moves through a canal formed by the